Neuromuscular Patients Undergoing Major Orthopedic Surgery
Enhanced Recovery After Surgery

Prior to Surgery Algorithm

Inclusion criteria:
- Neuromuscular patients undergoing major lower extremity orthopedic procedures

Exclusion criteria:
- Neurotypically developed patients
- Neuromuscular patients undergoing soft tissue work only
- Neuromuscular patients undergoing hardware removal only

Medication/diet instructions received at PAT:
- ***Medication:***
  - Patient takes all normal daily medications morning of surgery unless specifically instructed to stop
- ***Diet:***
  - Standard NPO guidelines
  - Carbohydrate-rich drink (Gatorade, Powerade, or Pedialyte) encouraged when NPO until 2 hours prior to procedure time
- ***Arrival time/location***

Abbreviations (laboratory and radiology studies excluded):
NPO - Nothing by mouth
PAT - Pre-Admission Testing
SDS - Same Day Surgery

Prior to surgery day

Patient scheduled for surgery

Patient seen in **Orthopedic Surgery Clinic and PAT** for pre-surgery evaluation to review the following:
- Introduction to ERAS
- Pain management and regional anesthesia
  - Anesthesia APRNs to chart review Orthopedic clinic notes for regional anesthesia recommendation
- Medication and diet instructions
- Discuss anesthesia risks and plan (including mitigation of pre-op anxiety)
- ERAS overview handout - English
- ERAS overview handout - Spanish

2 days prior to surgery date, SDS calls caregiver

Intraoperative to discharge algorithm

Intraop to Discharge Algorithm

Abbreviations (laboratory and radiology studies excluded):
SDS - Same Day Surgery
APS - Acute Pain Service
PENG - Pericapsular nerve group block
NG - Nasogastric
PO - By mouth
POD - Post-operative day
PONV - Post-operative nausea and vomiting
P.T. - Physical Therapy
TIVA - Total intravenous anesthesia
PACU - Post-Anesthesia Care Unit

Preoperative Care

- Active warming of patient in SDS
- Anxiolysis: midazolam per anesthesia team

Nerve Block Considerations
- Consider lower concentrations of local with high volume if fascial plane block
- Be mindful of toxic local anesthetic dosages when multiple blocks are performed
- If unable to perform peripheral nerve blocks consider epidural placement
- **Adjuncts**: Consider clonidine or dexmedetomidine and preservative free dexamethasone to prolong block

Intraoperative Care

Intraoperative Medication Bundle
- ***Antibiotics:***
  - Discuss at huddle
  - Administer before incision
- ***Antiemetics:***
  - Dexamethasone 0.1 mg/kg (max 8 mg)
  - Ondansetron 0.15 mg/kg (max 4 mg)
- ***Multimodal Analgesia:***
  - IV acetaminophen 12.5 mg/kg (max 1000 mg) at start of case
  - Ketorolac 0.5 mg/kg (max 15 mg) at closure
  - Consider dexmedetomidine bolus/infusion
  - Consider ketamine infusion
- ***Limit IV opioids:***
  - Fentanyl prn
  - Minimize long-acting opioids
- ***Tranexamic acid (TXA):***
  - If requested by surgeon
  - Bolus 30 mg/kg (up to 2 gram) then infusion 10 mg/kg/hr

Regional Anesthesia

Please Consult APS Physician

- **Discuss nerve blocks with surgeon at huddle**
  - ***If Proximal femoral osteotomy only:***
    - Femoral nerve block plus lateral femoral cutaneous nerve block **OR**
    - Suprainguinal fascia iliaca block **+/-** PENG block **OR**
    - PENG block + lateral femoral cutaneous nerve block
  - ***If Acetabuloplasty:***
    - Suprainguinal fascia iliaca block **+/-** PENG block **OR**
    - Quadratus lumborum block
  - ***If Tibial involvement:***
    - Popliteal nerve block with saphenous nerve block **OR**
    - Popliteal nerve block with adductor canal block
  - ***If Distal femur involvement:***
    - Femoral nerve block **OR**
    - Adductor canal block

Maintenance of Anesthesia
- ***Volatile*** or TIVA maintenance at discretion of anesthesiologist
- ***Normothermia:***
  - Patients with cerebral palsy are at high risk for hypothermia
    - Room temperature set to 70° F
    - Utilize Bair Hugger
    - Goal intraoperative temperature 36° - 38° C
- ***Euvolemia:***
  - Goal is clinical **euvolemia** (zero fluid balance, no net weight gain on POD #1)
  - **Isotonic fluids at 3-7 ml/kg/hr** (additional as clinically indicated)

Prior to Transfer to PACU
- Discontinue urinary catheter

Postoperative Care: Inpatient to discharge

Main Inpatient Goals of Care

Bowel regimen & Diet
- Daily bowel regimen
- Avoidance of NG tube
- Advance diet on POD 0
- Antiemetics: ondansetron and diphenhydramine prn

Postoperative Pain Management
Surgeon and anesthesiologist to discuss need for APS consult based on effectiveness of peripheral nerve blocks

Dexmedetomidine infusion (only if APS consulted) 0.1 - 0.3 mcg/kg/min
- May adjust depending on baseline neurological function

PO diazepam 0.1 mg/kg q6 hrs scheduled (unless otherwise discussed with surgeon)
IV acetaminophen 12.5 mg/kg (max 1000 mg) q6 hrs scheduled
Change to PO on POD 1
IV ketorolac 0.5 mg/kg (max 15 mg) q6 hrs alternating q3 hrs with acetaminophen
Oxycodone 0.1 mg/kg q 4hrs prn once tolerating clears
IV hydromorphone (only if APS consulted) 5-10 mcg/kg or morphine 0.05-0.1 mg/kg q4 hrs prn severe breakthrough pain or if not tolerating PO intake

Physical Therapy
- P.T. consulted on POD 1

Discharge home with post-operative follow up visit in two weeks

Prior to surgery algorithm

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Objective of ERAS Model

This Enhanced Recovery After Surgery (ERAS) pathway aims to standardize perioperative care and accelerate recovery for neuromuscular patients undergoing major orthopedic surgery starting preoperatively with a bowel regimen, carbohydrate-rich fluid intake on the day of surgery, and preoperative warming. The pathway includes a multimodal pain management regimen utilizing single-shot peripheral nerve blocks that aims to reduce opioid utilization, decrease adverse drug-related side effects, expedite the resumption of oral intake, and promote the return of bowel function.

Background

Patients with cerebral palsy and those with other neuromuscular diagnoses often require multiple orthopedic surgical procedures. These procedures require specialized pain management strategies secondary to increased muscle tone and spasticity, which can be worsened by inadequate pain control. In addition, they have multiple medical comorbidities that can be worsened by traditional pain management with opioids.

Traditionally, pain control for these surgeries has required epidural catheters, but there are many patients in this population (those with a baclofen pump, dorsal rhizotomy, and prior spinal fusion) that are not candidates for epidural catheters. Replacing an indwelling epidural catheter with single-shot peripheral nerve blocks at the beginning of the surgery may allow for earlier patient mobilization and earlier discharge from physical therapy and will facilitate the removal of the Foley catheter at the completion of the case. This patient population is at risk for many perioperative difficulties in addition to pain control, which includes intraoperative hypothermia and delayed return of bowel function (Liu et al., 2017; Melnyk et al., 2011; Doyle et al., 2022).

Target Users

- Pediatric surgeons
- Nurse practitioners
- OR nurses
- Anesthesiologists

Target Population

ERAS Inclusion Criteria

Neuromuscular patients undergoing major lower extremity orthopedic procedures.

ERAS Exclusion Criteria

- Neurotypically developed patients
- Neuromuscular patients undergoing only soft tissue work
- Neuromuscular patients undergoing hardware removal only

Core Principles of ERAS

- Preoperative education of patients and their families with an introduction to ERAS
- Reduced preoperative fasting, with clear liquid oral carbohydrate loading 2 hours prior to surgery
- Goal-directed strict intraoperative intravenous fluid therapy guidelines to avoid hypo-or hypervolemia
- Avoidance of preoperative mechanical bowel preparation
- Avoidance of routine nasogastric tube use
- Minimizing long-acting opioid analgesia in favor of regional anesthesia with epidural and/or local anesthesia for intraoperative and postoperative pain control when appropriate and using alternative non-opioid medications when appropriate (e.g., non-steroidal anti-inflammatories or acetaminophen)
- Early postoperative mobilization
- Early postoperative enteral feeding

ERAS Management Recommendations:

Preoperative Care

- This ERAS protocol begins well before the surgical date. The concept of ERAS is presented to the patient/family at the initial surgical appointment and reinforced preoperatively.
- At the initial surgical appointment, the patient and family are provided with educational items on preoperative diet restrictions, risks of anesthesia, and pain management.
- Some of the core concepts of ERAS, including the emphasis on early post-op PO intake and a multimodal pain management approach, are also discussed. Expectation management is crucial in the preoperative phase. Two handouts (Appendices A and B), approved by CM's Health Literacy Committee, are given to the family prior to departing their pre-surgery appointment.

- Patients and families are provided with contacts for Dr. Keeler's nurse to answer any questions they may have prior to the procedure.
- On the morning of surgery, the patient drinks carbohydrate-rich clear fluids up to two hours before the procedure start time.

Intraoperative Care

The principal goals during the intraoperative care of these patients are:

- Multimodal approach to pain management
  - Discuss peripheral nerve blocks with the surgeon at huddle
  - Minimize the use of long-acting opioids
- Postoperative nausea and vomiting prophylaxis with dexamethasone and ondansetron
- Fluid management goal of clinical euvolemia
- Ensure that antibiotics are administered prior to surgical incision
- Maintain normothermia throughout the entire procedure
- Discontinue urinary catheter prior to transfer to PACU

Postoperative Care

The principal goals during the postoperative care of these patients are:

- Move toward PO intake as early as possible and avoid NG tube placement
- Advance diet on postoperative day 0
- Prevent/treat postoperative nausea and vomiting with dexamethasone and ondansetron prn
- Multimodal pain control: Consult acute pain service on all cases and write all pain orders on postoperative day 0
  - Dexmedetomidine infusion
  - PO diazepam
  - IV acetaminophen
  - IV ketorolac
  - Oxycodone prn once patient tolerates clears
  - IV hydromorphone or morphine prn for severe breakthrough pain or if not tolerating PO intake
- Physical therapy (PT) Consult

Additional Questions Posed by the ERAS Committee

No clinical questions were posed for this review.

Key Metrics To Be Monitored:

Preoperative	Intraoperative	Postoperative
Carbohydrate-rich drink	IV acetaminophen	PACU PONV score
	PONV prophylaxis	Average pain score
	ABX prior to incision	Long-acting opioids
	Ketorolac	Diazepam
	Normothermia	Length of stay
	Euvolemia	Dexmedetomidine infusion
	Nerve blocks/neuraxial anesthesia	
	Long-acting opioids	

Value Implications

The following improvements may increase value by reducing healthcare costs and non-monetary costs (e.g., missed school/work, loss of wages, stress) for patients and families and reducing costs and resource utilization for healthcare facilities.

- Decreased inpatient length of stay
- Decreased unwarranted variation in care
- Improved communication between patients and the care team throughout the perioperative period
- Improved post-operative pain control

Organizational Barriers and Facilitators

Potential Barriers

- Variability of acceptable level of risk among providers
- Challenges with follow-up faced by some families

Potential Facilitators

- Collaborative engagement across care continuum settings during ERAS development
- High rate of use of ERAS

Power Plans

- There are no Power Plans associated with this ERAS pathway

Associated Policies

- There are no associated policies with this ERAS pathway

Education Materials

- ERAS overview handout
  - Intended to be a general handout encompassing the key concepts and plan for an ERAS pathway
  - Found on the CM external website for each ERAS pathway
  - Available in English and Spanish

ERAS Pathway Preparation

This care process was prepared by the Evidence Based Practice (EBP) Department in collaboration with the Neuromuscular Patients Undergoing Major Orthopedic Surgery ERAS pathway composed of content experts at Children's Mercy Kansas City. If a conflict of interest is identified, the conflict will be disclosed next to the committee member's name.

NM Patients Undergoing Major Orthopedic Surgery ERAS Committee Members and Representation

- Nichole Doyle, MD, FASA | Anesthesiology | Committee Co-Chair
- Emily Weisberg, MD, FASA | Anesthesiology | Committee Co-Chair
- Kathryn Keeler, MD | Orthopedic Surgery | Committee Member
- Azita Roberson, MSN, RN, CPN, APRN, FNP-C | Anesthesiology | Committee Member

EBP Committee Members

- Todd Glenski, MD, MSHA, FASA | Anesthesiology, Evidence Based Practice
- Megan Gripka, MT (ASCP) SM | Evidence Based Practice
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ERAS Development Funding

The development of this ERAS pathway was underwritten by the following departments/divisions: Evidence Based Practice, Anesthesiology, and Orthopedic Surgery.

Conflict of Interest

The contributors to the Neuromuscular Patients Undergoing Major Orthopedic Surgery ERAS have no conflicts of interest to disclose related to the subject matter or materials discussed.

Approval Process

- This product was reviewed and approved by the Neuromuscular Patients Undergoing Major Orthopedic Surgery ERAS Committee, Content Expert Departments/Divisions, and the EBP Department.
- Pathways are reviewed and updated as necessary every 3 years within the EBP Department at CMKC. Content expert teams are involved with every review and update.

Review Requested

Department/Unit	Date Approved
Anesthesiology	August 2022
Orthopedic Surgery	September 2022
Evidence Based Practice	September 2022

Version History

Date	Comments
October 2022	Initial version – algorithm, synopsis, and education developed
December 2024	Version two – drugs utilized in post-op care and recovery were reviewed and updated by the committee

July 2025	Updated medications in the Intraoperative Medication Bundle per Anesthesiology and Orthopedic Surgery committee members

Date for Next Review:

- December 2027

Implementation & Follow-Up

- Once approved, the ERAS pathway was presented to appropriate care teams and implemented.
- Key metrics will be assessed and shared with the appropriate care teams to determine whether changes are needed.
- Education tools for patients and families were created for pre-surgery visits to provide an overview of the ERAS pathway. Health literacy reviewed the tool.
- Education was provided to all stakeholders:
    - Nursing units where Neuromuscular Patients Undergoing Major Orthopedic Surgery ERAS is used
    - Departments of Orthopedic Surgery and Anesthesiology
    - Resident physicians

Disclaimer

When evidence is lacking or inconclusive, options in care are provided in the supporting documents that accompany the ERAS pathway.

These ERAS pathways do not establish a standard of care to be followed in every case. It is recognized that each case is different, and those individuals involved in providing health care are expected to use their judgment to determine what is in the best interests of the patient based on the circumstances existing at the time.

It is impossible to anticipate all possible situations that may exist and to prepare ERAS pathways for each. Accordingly, these ERAS pathways should guide care with the understanding that departures from them may be required at times.

References

Liu, V.X., Rosas, E., Hwang, J., Cain, E., Foss-Durant, A., Clopp, M., et al. (2017). Enhanced recovery after surgery program implementation in 2 surgical populations in an integrated health care delivery system. *JAMA Surg, 152,* e171032. https://doi.org/10.1001/jamasurg.2017.1032

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